

ODORIZATION - A REGULATORY PERSPECTIVE

Edward E. Fant
Pipeline Specialist, Pipeline Safety Division
Transportation Safety Institute
Research and Special Programs Administration
U.S. Department of Transportation
Oklahoma City, Oklahoma 73125

ABSTRACT

The Federal Pipeline Safety Regulations require that combustible gases in certain pipelines be detectable either by a natural odor or by odorization at 1/5 the lower explosive limit by a person with a normal sense of smell. This paper will review the applicable regulations addressing odorization and other regulations which affect an adequate odorization program.

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INTRODUCTION

Title 49 Part 192 of the Code of Federal Regulations (49 CFR Part 192 or Part 192) are the minimum federal safety standards which govern the transportation of gas by pipeline. Section 625 of Part 192 addresses the odorization of gas. Although we will review other sections of the code which will affect odorization and section 625, we will primarily focus on (1) which lines require odorization; (2) the detectable limits of the gas; (3) odorants and odorizing considerations; and (4) monitoring a pipeline system to ensure that the odorization program is meeting the requirements of the regulations.

Before we begin examining specific odorization requirements however, I would like to discuss regulatory language, examine the notion of "retroactive", discuss how that impacts the odorization requirement and review a few definitions that affect odorization.

BACKGROUND

Regulatory Language

The regulations are written in two different types of language; specification and performance.

Specification language is a detailed and exact statement prescribing materials, dimensions, and workmanship for something being built, installed or manufactured. For example, plastic pipe used in gas distribution systems must meet ASTM D 2513. Only plastic pipe which meets this specification satisfies the regulations. A company that uses plastic pipe meeting another specification, ASTM 1120 for example, would be in violation of Part 192. Specifications have several advantages: it is easy for an operator to choose a course of action that meets the regulation and it makes it easy for governmental inspectors to determine whether or not an operator is in compliance. There are several disadvantages to specifications, however. The desired level of safety is not stated, variations in environment and operating conditions are not considered, and specification language may stifle motivation and/or require unnecessary cost. For this reason most of the regulations are written in performance language.

Performance language prescribes a level of safety. It leaves the method or "how to" to the operators discretion. As we will explore later many of the odorization regulations are written in performance language. For example, periodic sampling is required to assure the proper concentration of odorant. What is meant by periodic? What type of sampling is required? This points to two of the major disadvantages of performance language: many times it is difficult for an operator to understand what is needed to comply with the regulations and it makes it difficult for the operator and government inspector to determine compliance. This last item causes many disagreements between pipeline operators and government inspectors. The company believes they are satisfying the regulations and inspectors do not. It may be important to point out that in many of these disputes, industry standards and practices are used to determine whether or not an operator is satisfying the performance language. Even with these problems, The advantages of

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performance language outweigh the disadvantages. Performance language allows for adaptation to the individual situation, encourages development and adoption of new and improved methods, materials, and equipment, and promotes safety as the end instead of the "letter of the law" which permits a company to choose the most economical solution to achieve the required level of safety. As we discuss the regulatory requirements addressing odorization, the significance of performance regulations as compared to specification language will be demonstrated and more completely appreciated.

Retroactive

Part 192 is divided into Subparts. Each Subpart addresses specific functions of pipeline operations. For example Subpart C addresses pipe design, Subpart G, Construction of Mains and Transmission Lines, Subpart L Operations and Subpart M Maintenance. Some Subparts are only applicable for pipelines placed into service after March 12, 1971 or the effective date of a specific amendment, while other subparts are applicable to pipelines regardless of the date the pipeline was placed into service. The latter subparts we call **retroactive**. Subparts A, I, K, L, & M are retroactive. Section 625 is found in Subpart L, therefore regardless of when a pipeline was placed in to service the odorization requirements are applicable. Note, that I did not say all pipelines must be odorized, I said that Section 625 is applicable. As we will see later, Section 625 does not require all pipelines to be odorized.

Definitions

Part 192 is the minimum standard for the transportation of gas by pipelines. The definition of **transportation of gas** is "the gathering, transmission or distribution of gas by pipeline or the storage of gas, in or affecting interstate commerce." If a pipeline is not involved in "transportation" Part 192 is not applicable and therefore the odorization requirements are not applicable.

Natural gas is produced in oil or gas wells. Normally the first pipeline which gas flows through after leaving the production facilities is the **gathering line**: in fact, the definition of a gathering line is a "pipeline that transports from a current production facility to a main". A **transmission line** is a "pipeline, other than a gathering line, that (a) transports gas from a gathering line or storage facility to a distribution center or storage facility; operates at a hoop stress of 20 percent or more of SMYS; or (c) transports gas within a storage facility". A **distribution line** is a "pipeline other than a gathering line or transmission line. Distribution lines are either mains or services." A **main** is a "distribution line that serves as a common source of supply for more than one service line" and a **service line** is a "distribution line that transports gas from a common supply to a customer meter or the connection to the customers piping which ever is further downstream". The customer meter is the "meter that measures gas to the **consumer**". Consumer piping is not subject to Part 192. Several comments regarding these definitions must be made: (1) Gathering lines in rural locations are not subject to Part 192. Pipelines in non-rural areas i.e.; inside cities, towns, villages, subdivisions etc. are subject to the regulations and must meet the requirements applicable to transmission lines, and (2) Gas is defined as natural gas, flammable gas, or gas which is toxic or corrosive, therefore gases such as

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LPG, hydrogen or Acetylene, if being transported by pipeline or subject to Part 192 and must meet all applicable subparts. LPG transported across country by pipeline is normally in the liquid state and subject to Part 195, the hazardous liquids pipeline safety rules, but LPG serving mobile home parks through systems (series of mains and services lines) which serves more than 10 customers or in a system any portion which is located in a public place (such as a highway) is subject to Part 192 and Section 625.

DISCUSSION

§192.625

As stated earlier I would like to focus on (1) which lines are required to be odorized (2) the minimum detectable limits (3) odorant and odorizing requirements and (4) monitoring a system to insure regulatory adequacy.

Lines requiring odorization. Section 625(a) requires gas in certain pipelines to contain a natural odorant or to be odorized. We will discuss the natural odorant versus odorization issue when we discuss detectable limits, but for now lets define which pipelines must transport gas which is detectable. These pipelines are (a) distribution pipelines and (b) transmission pipelines within class 3 and 4 locations. There are however, exemptions for some transmission lines in class 3 and 4 locations and we will examine these exemptions later.

First lets look at the odorization of distribution pipelines. As defined earlier distribution pipelines are pipelines which are involved in commerce and are not transmission or gathering lines. Generally when we think of distribution pipelines we think of the local natural gas utility system consisting of many miles of mains and hundreds of service lines. However, a distribution line may be a single line serving a consumer which is operating at less than 20% SMYS from a transmission line (a service line) or it may be a system transporting LPG through a trailer park. If a pipeline meets the definition of main or service line it is a distribution line and must be odorized.

Transmission lines in class 3 and 4 locations must be odorized. "Class location" is a term used in the regulations to denote the population density surrounding the pipeline. It is determined by the number of dwelling units within 220 yards on either side of the pipeline for a 1 mile stretch or the land or building use within a hundred yards of the pipeline. When there are 46 or more buildings intended for human occupancy within the 1 mile by 440 yards or a building or area occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12 month period the area is class 3. A class 4 location is where buildings with four or more stories are prevalent within the 220 yards on either side of the pipeline. Transmission lines traversing these areas must be odorized unless they meet one of the 3 exemptions: (1) At least 50% of the length of the pipeline downstream from that location is in a class 1 or 2 location (less than 46 buildings), (2) The transmission line delivered gas to an exempted facility **prior to May 5, 1975**, or (3) a transmission line lateral with at least 50% of the line in a class 1 or 2 location. Lets look at these exemptions more closely.

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(1) At least 50% of the length of the pipeline downstream from that location is in a class 1 or 2 location (less than 46 buildings):

When the pipeline safety regulations were originally written in the late 60's and early 1970's there was a lot of concern regarding the odorization of transmission lines. Several states had regulations addressing odorization and the federal standards would prevent these states from enforcing their odorization regulations on interstate pipelines. These states wanted more stringent odorization requirements than were proposed. At the same time, many in the industry were afraid that more stringent requirements would affect their operation and require costly odorization for pipelines which for the most part were traversing unpopulated or sparsely populated areas. For this reason odorization requirements for transmission lines were not issued until May 9, 1975. The new regulation was more or less a compromise between the two groups. Transmission lines in class 3 and 4 are exempted from the odorization if 50% of the line downstream from that location is in a class 1 or 2 area. For example, if we have a transmission line 100 miles long meeting conditions: From mile pole (MP) 00 to MP 38 is in class 1, MP 38 to MP 48 is in class 3, MP 48 to 82 is in class 1 and 2 locations, MP 82 to 92 is in class 3 location and MP 92 to MP 100 is in class 2 the pipeline would not be required to odorize until MP 82. The reason odorization would not be required at MP 38 is because more than 50% of the line downstream is in class 1 and 2 (20 miles in class 3 verses 42 miles in class 1 and 2. On the other hand odorization would be required at MP 82 because less than 50% downstream from MP 82 is in class 1 or 2 (8 miles is in class 1 or 2 and 10 miles is in class 3). One issue concerning "that location" is where do you start counting. Some operators want to go to the downstream boundary of the class location and begin there (MP 92 in my example). By doing this 100% of the line downstream from "that location" is in class 1 or 2. Doing this would obviously not be in the interest of public safety and is not the correct method in determining the downstream class location. Measurement should begin on the upstream side of the class 3 or 4 location.

(2) Transmission lines delivering gas to an exempted facility **prior to May 5, 1975**

The next exemption addressed in section 625(b) are pipelines delivering gas to certain facilities. These exempted facilities are (a) an underground storage field, (b) a gas processing plant, (c) an industrial plant using gas in a process where the presence of odorant: (1) makes the end product unfit, (2) reduces the activity of the catalyst, or (3) reduces the percentage completion of a chemical reaction. Note that this exemption only applies if the pipeline delivered gas to an exempted facility **prior to May 5, 1975** from that line.

If the line was constructed after May 5, 1975 there is no way that this exemption could apply. An operator should have documentation that substantiates that the end use meets one of these conditions and that the pipeline delivered to the facility prior to May 5, 1975 if this exemption applies. If a facility requires unodorized gas from a line after May 5, 1975 it is up to the facility to treat or strip odorant from the gas stream.

(3) the final exemption applies to transmission laterals delivering gas to distribution centers

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When more than 50% of the lateral is in class 1 and 2 locations and the line is serving a distribution center, this exemption applies.. For example a 20 mile lateral would not have to be odorized if 10.1 miles were in class 1 or 2 locations, regardless of the dispersion of the class location along the line.

The definition of distribution center is not in the regulations. However normal industry use refers to the point where gas enters piping primarily to deliver gas to customers who purchase it for resale¹. DOT Interpretation 82-3 indicates that pipelines delivering gas to "large volume customers" which operating pressures and throughput are essentially the same as pipelines delivering to distributing centers in the area could be classified as transmission lines and therefore are exempted from the odorization requirements².

Unless a transmission line meets one of these three requirements, it must be odorized in class 3 and 4 locations. It should also be reiterated that gathering lines that are within the jurisdictional limits of cities, towns, etc. must meet transmission line requirements including odorization.

Detectable Limits

When pipelines are required to be detectable, Part 192 requires the pipeline to contain either a natural odorant or be odorized so that at a concentration in air of 1/5 the lower explosive limit (1/5 LEL) the gas is readily detectable by a person with a normal sense of smell. There are 4 areas that need to be addressed: (1) "readily detectable", (2) 1/5 LEL; (3) a person with a normal sense of smell and (4) natural odor versus odorant.

Readily Detectable. The purpose of odorization is to warn customers and others of gas leaks before they become a hazard. The dictionary defines detectable as capable of being detected, that is, discovered. "Readily" means without hesitation or delay, quickly or without difficulty. Combining these we get the objective of this verbiage in the regulations: A person with a normal sense of smell must be able to quickly, without hesitation or difficulty be able to discover gas in the atmosphere before he is in danger. If a person questions or has to hesitate whether he smells gas or not (at the required limits), the odor is not readily detectable.

1/5 LEL. Gases have different LELs. Natural Gas is considered to have an LEL of 4.5% or 5% concentration of gas in air. This is dependent on the percentages of the various constituents in the gas. LPG on the other hand has an LEL of 2.5% concentration of LPG in air.

Using these two gases as examples we can demonstrate how to determine 1/5 of LEL:

The fraction 1/5 is equal to 0.20.

For a gas with a LEL of 5%, the calculation is $0.05 \times 0.20 = 0.01$ or 1% concentration of gas in air.

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If the gas in your area has an LEL of 4.5%, the calculation is $0.045 \times 0.20 = 0.009$ or 0.09% concentration of gas in air.

1/5 LEL of LPG is 0.5%: $0.025 \times 0.20 = 0.005$. This is the level at which the odorant in LPG must be readily detectable.

Normal Sense of Smell. While scientists, statisticians and others argue the finer points of this issue, let's look at the regulatory perspective of a person with a normal sense of smell. As stated earlier the reason for odorizing gas is to warn people that gas is in the atmosphere before it reaches hazardous levels. We want the average or typical person to be able to detect gas in the atmosphere at or below 1/5 the lower explosive limit³.

Odorization versus Natural Odorant. From the preceding discussion it should be clear that the gas must be detected at 1/5 LEL by a person with a normal sense of smell. This requirement is applicable 100% of the time, 7 days a week, 24 hours a day. While there may be some locations in the United States where the gas produced by a well could meet this requirement with its natural odorant, because of the nature of production, gathering, and treatment of gas, this is difficult for most. A pipeline being adequately odorized by specific wells given specific operating parameters may be upset by conditions which may be out of the operator's control. A well or wells could be shut in upsetting the balance and having a negative effect on the proper detectable limits. In addition, persons living in producing areas may not be able to differentiate leaks from the pipeline from the ambient atmosphere. In other words, the typical person in this area may not be able to "discover quickly without difficulty" that a potential hazard exist from a leaking pipeline. Odorization is the answer to this problem.

Odorant and Odorizing

Section 625 gives specific requirements for the odorants;

- (1) they may not be deleterious to persons, materials or pipe at the concentrations in which they are used;
- (2) the products of combustion may not be toxic or corrosive; and
- (3) the odorant may not be soluble in water to an extent greater than 2.5 parts per 100 parts of water.

This requirement is one that is easily met by purchasing odorant from respectable odorant suppliers.

Section 625(f) requires that odorant must be introduced into the gas stream without wide variation. The concern is twofold: first, that the gas stay readily detectable at or below the 1/5 LEL criteria and second that the gas odor does not get so strong that it causes unwarranted public reaction⁴. This wide variation could be caused by several factors including, changing operating conditions, using the wrong odorization equipment, using the proper equipment incorrectly, or incorrect installation of the equipment. For example, installing a bypass odorizer above ground without insulation subjects the odorizer to ambient temperatures which could effect the vaporization of the odorant which affects the introduction rate.

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Odorization rates should be calculated and compared periodically to assure that odorization rates are more or less constant and there is not wide variation. Because of the differences in odorant and operating conditions, DOT does not have a "limit" for wide variation.

Monitoring

Periodic sampling is required to insure that pipelines which require odorization are adequately odorized. Three major issues stand out when thinking of monitoring (1) What does "periodic" mean; (2) the method of monitoring and (3) where to monitor.

In our discussion of regulatory language we discussed the advantage of performance language. It allows the operator flexibility to choose a course of action based on the uniqueness of each system. Here we have a good example of the reason for performance language. Some operations close to production fields where wet gas is encountered may need to be checked weekly or even daily, while another system may only require monitoring monthly or quarterly. Some other considerations in determining the sampling period would be size of system, any new lines in the area, age of the system, average number of leaks in the system, type of pipe, type of odorant and past experience in odorant sampling in the area⁵.

While there may be discussion of what is meant by "normal sense of smell", I do not believe that anyone would disagree that it would be difficult if not impossible to determine if the odorant is "readily detectable at 1/5 LEL using only the nose. To determine this a person must combine the smelling with some type of equipment. Although there is equipment available that can quantify odorant in the gas such as titrators, gas chromatography etc., these do not accurately correlate to detectability and would not therefore satisfy the regulatory requirements for deductibility. There must be some way to indicate at what level the gas was detected.

Just as important as determining the frequency of monitoring and choosing the proper equipment to supplement sniffing is where to monitor. Locations should be chosen that are representative of the system and also in areas where you might expect problems such as low flow areas. Remember that persons in all areas of your system must be able to detect the gas in air at 1/5 the lower explosive limit.

Miscellaneous Regulations

In addition to Section 625 there are 5 other sections which affect the adequacy of an odorization program. These are Sections 192.13, 603, 605, 613, and 615.

§192.13, 603, and 605 require companies to have written procedures covering normal operations. This includes odorization. Government inspectors will be reviewing your procedures to insure that they cover all the areas required by section 625, the pipelines requiring odorization, which odorant you use, how you odorize including types of odorant, method of determining odorization rates and monitoring program. Records substantiating that you are following your odorization procedures should be maintained and will be reviewed by regulatory inspectors.

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Section 13(c) requires operators to follow their procedures and to modify them when appropriate. If you are not following your procedures or maintaining the records required by your procedure that in itself is a violation of Part 192.

§192.613 requires continuing surveillance for among other things, class location changes and unusual operating maintenance conditions. A change in class location from class 1 or 2 to a class 3 or 4 could cause a pipeline to lose its exemption. There also may be unusual conditions such as "wet gas" which could drastically affect the odorization program. You should be sure your surveillance program contains these provisions.

Finally, §192.615 Emergency Plans, requires that gas companies inform the public of how to recognize a gas emergency for the purpose of reporting it. This includes familiarizing them with the "smell" of gas in your system and informing them of what they should do when they smell it.

CONCLUSION

The pipeline safety regulations are minimum standards. This paper has addressed odorization from that perspective noting that most of the Section 625 is written in performance language. It is up to gas pipeline operators to know which regulations apply to their pipelines, know the specific requirements for any unusual or specific operating conditions and choose the proper course of action.

REFERENCES CITED

1. DOT Letter, Mr. Simpson, East Tennessee Gas, August 2, 1978
2. DOT Interpretation #82-3, May 6, 1982
3. DOT Letter, Richard Kutzleb, Heath Consultants, October 31, 1973
4. DOT Letter, Richard Kutzleb, Heath Consultants, October 31, 1973
5. DOT Letter, Richard Kutzleb, Heath Consultants, October 31, 1973